COPY 2

# *Bursera simaruba* (L.) Sarg. Almácigo, gumbo limbo

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## Burseraceae Bursera family

**John K. Francis**

UNIVERSITY OF MINNESOTA
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*Bursera simaruba* (L.) Sarg., known as almácigo (Spanish) and gumbo-limbo (English), also has more than 50 other common names (*11*) and is a medium-sized tree of dry and moist forests in the Caribbean region. Its moderate size, compact crown, shiny green foliage, and brown, birchlike bark have led to its use as an ornamental in many dry areas (fig. 1). The wood is of low density but has a number of uses.

## HABITAT

### Native Range

The natural range of almácigo extends from southern Florida and the Bahamas through the Greater and Lesser Antilles and into northern South America (*17, 18),* (fig. 2). It also grows on both coasts of central Mexico, through Central America, and along the Pacific Coast of South America nearly to the Equator (*16, 27*). The range stretches from about 10 to 27 °N. latitude. There are no reports of naturalization of almaćigo beyond its native range.

### Climate

Almácigo may be found growing in tropical very dry and dry and subtropical dry and moist forest life zones (life zones according to Holdridge *15*). Mean annual rainfall in areas where the species is most abundant ranges from 500 to 1400 mm (*24*). Almácigo may be found in even wetter areas but is confined to such droughty microsites as crests of rocky ridges and sand hills near the coast. This tree is deciduous and endures dry seasons 1 to 6 months long. During the warmest month mean temperatures average about 28 °C for coastal areas across the range, and during the coolest months mean temperatures range from 18 °C in the north to 26 °C in the south (*14, 34*). In Florida, and possibly Mexico, the species is subject to rare frosts.

### Soils and Topography

Almácigo grows on a wide variety of sites. Generally, it is most common on dry, rocky limestone hills and calcareous soils; however, it grows to greater sizes in alluvial valleys (*17, 20, 24*). Soils with textures ranging from sand to clay and pH's ranging from 5.5 to 8.5 are colonized. The species can tolerate salt spray and some soil salinity (*24*). It is often found on elevated areas above beaches and on slight rises just inland from coastal mangroves. The aspect and slope of sites do not appear to be very important factors affecting distribution (author, personal observation). Most almácigo trees are found at low elevations in coastal areas (*17*); however, the tree also grows well inland in some areas and can be found at elevations of up to 1,800 m in Guatemala (*24*).

### Associated Forest Cover

Across its wide range, almácigo forms many associations. A few are listed below, beginning at the northern extent of the range and proceeding south. The upper Florida Keys commonly support *Mastichodendron foetidissimum* (Jacq.) H.J. Lam., *Metopium toxiferum* (L.) Krug. & Urban, *Lysiloma latisiliquum* (L.) Benth., *Chrysophyllum oliviforme* L., *Gymnanthes lucida* Sw., and *Guaiacum sanctum* L. in association with almácigo (*8*). On the slopes of eastern Mexico, an evergreen forest that typically contains almácigo is dominated by *Brosimum alicastrum* Sw. and occasionally *Celtis monoica* (Hemsl.) Sharp (*30*). The semiarid, open forest of the Liguanea Plain of Jamaica contains almácigo with *Haematoxylum campechianum* L., *Piscidia piscipula* (L.) Sarg., *Prosopis pallida* (H. & B. ex Willd.) H.B.K., and *Acacia villosa* (Sw.) Willd. (*33*). In the dry woodlands of the limestone hills of Puerto Rico, almácigo accounts for much of the

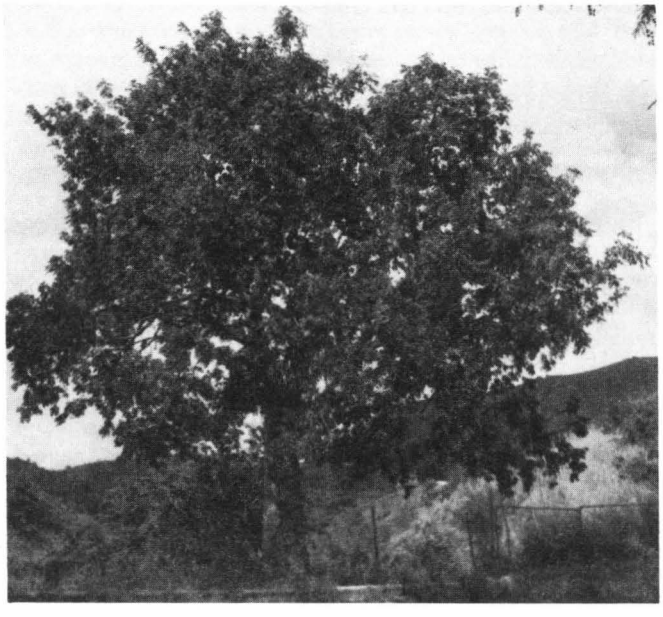

**Figure 1.**—*An almácigo* (Bursera simaruba) *tree growing in Puerto Rico.*

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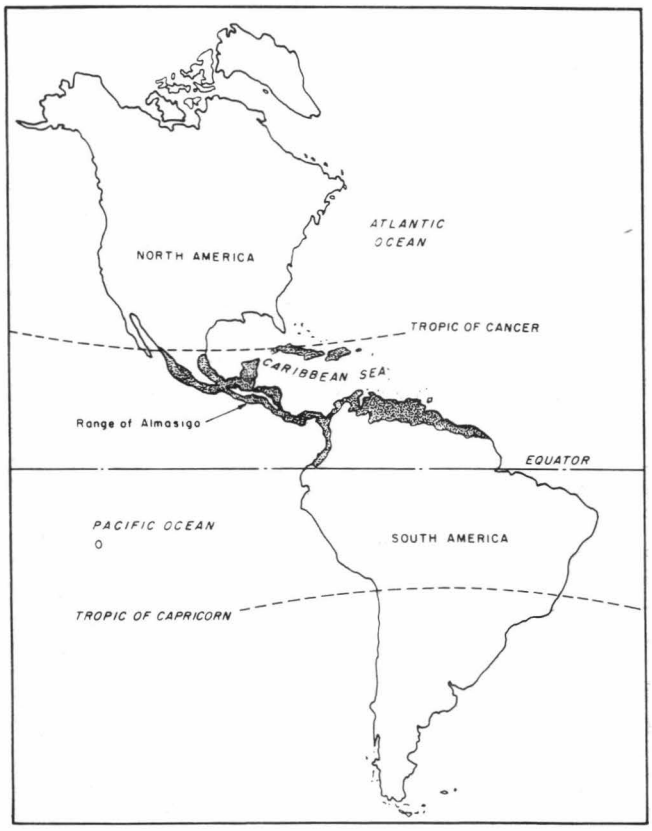


**Figure 2.**—*The natural range of almácigo* (Bursera simaruba) *in tropical America.*

basal area and shares dominance with *Coccoloba diversifolia* Jacq. (*5*). On the west coast of Colombia, almácigo grows in dry forests in association with *Acacia farnesiana* (L.) Willd., *Bursera tomentosa* (Jacq.) Tr. & Pl., *Pithecellobium* sp., and *Prosopis juliflora* (Sw.) DC. (*16*).

## LIFE HISTORY

### Reproduction and Early Growth

**Flowering and Fruiting.**—Almácigo is usually dioecious (male and female flowers on different trees), but some trees produce polygamous flowers (*17, 35*). The pale green to white flowers are tiny (1 to 7 mm across) and form clusters (panicles) at the ends of branches (*17, 19, 35*). Male flowers look like female flowers but are borne in greater numbers (up to 5,000 at a time) and produce more nectar (*35*). Pollinating insects are attracted in great numbers. Flowering usually coincides with the flushing of new leaves at the end of the dry season but varies by locality (*19*). After pollination, the fruits expand to full size in less than a week; however, the embryo remains minute for 8 months and then fills out just before fruit ripening (*35*). The fruits, 8 to 9 mm in diameter and 10 to 15 mm in length, are triangular or diamond-shaped in cross section and tapered at the ends. The single seed is surrounded by a bony shell within a resinous, fleshy pericarp (*17, 19, 27, 35*).

**Seed Production and Dissemination.**—Almácigo trees begin fruit production when 5 years old, and even earlier when grown from cuttings (*4*). Large trees can produce up to 60,000 seeds in one crop, but the average is close to 600 seeds per tree (*35*). On the other hand, small, open-grown trees, although not necessarily young trees, produce sparse crops of seeds. The seeds mature during the middle or end of the dry season (*19, 35*) and are dispersed by many bird and mammal species. Some strip off the fruit and drop the seeds while others swallow the fruits whole and later expel the seeds unharmed (*32, 35*). One hundred air-dry seeds collected in Puerto Rico averaged 0.077 ± 0.002 g per seed or 13,000 seeds per kilogram (author, personal observation).

**Seedling Development.**—Forty-percent germination of viable seeds can be expected within 20 days (*4*). No pretreatment is necessary (*12*). Two attempts in Puerto Rico to germinate seeds of almácigo failed (*10,* author, personal observation). This failure was probably caused by low germination rates in general and a need to scarify the hard testa. The sparseness of seedlings under almácigo trees and in openings nearby seems to indicate low germination rates of naturally disbursed seeds, at least in Puerto Rico. Small wildlings (about 10 cm tall) survived transplanting into containers and developed to outplanting size (0.4 m tall) in 6 to 8 months (author, personal observation). Exposure to full or nearly full sunlight appears to be a requisite for best growth. Planting containerized nursery stock and cuttings or transplanting wildlings are all viable methods for establishing ornamentals and timber plantations. No data are available to compare planting methods.

**Vegetative Reproduction.**—Propagation of almácigo by cuttings is easy (*27, 39*). Branches up to 10 cm in diameter will root when one end is buried in the ground (*31*). Coppicing is vigorous when sapling to small sawlog-sized trees are cut (author, personal observation), and windthrown trees are reported to sprout and regenerate themselves (*24*). After stands of trees have been cut, coppicing is probably a more important means of reproduction than seeds.

### Sapling and Pole Stage to Maturity

**Growth and Yield.**—Almácigo trees generally grow at a moderate rate. In a subtropical moist forest on thin clay soil over porous limestone, dominant and codominant trees with initial diameters at breast height (d.b.h.) of 4 to 15 cm averaged a periodic annual diameter increment of 0.28 cm/yr over a 17-yr period.[1] An experimental plantation of almácigo in Costa Rica with trees spaced at 2 by 2 m attained a basal area of 11 $m^2$/ha and an average d.b.h. of 9 cm in 5 years (*13*). Almácigo is a long-lived tree and is able to reach a 1-m d.b.h. and a 30-m height on the best sites (*27*). Ordinarily, heights do not exceed 20 m, and diameters do not exceed 0.6 m. When the tree grows on very poor sites, it rarely exceeds 3 to 5 m in height. The trunks tend to be stout compared to other species around them, with heavy branches emerging 2 to 4 m above the ground. On good sites, boles are clean and straight. Epicormic branching rarely, if ever, occurs. Almá-

[1] Calculated from data on file at the Institute of Tropical Forestry, USDA Forest Service, Río Piedras, Puerto Rico.

cigo trunks shrink substantially during the dry season and swell again after rains as they accumulate water.[2]

**Rooting Habit.**—Seedlings rapidly produce a long taproot. Trees in favorable habitats are normally deep rooted (*11*). Usually, there is no buttress, but lateral roots on old trees can become massive and protrude above the ground near the trunk. However, the species does not generally damage sidewalks and other structures (*31*).

**Reaction to Competition.**—Almácigo is intolerant of shade. Reproduction usually does not occur under closed stands of almácigo or other species that cast moderate to dense shade (author, personal observation). However, at least one reference says that the species is tolerant of shade at all growth stages (*24*). Almácigo tolerates "open shade" as along streets and beaches (*31*). Successful reproduction occurs in two situations: within low, dry forests on dry, rocky sites, and as a secondary species arising in large openings in moist, fertile sites. Seedlings and sprouts can grow up through thin and open stands and can compete with weeds and brush in openings. Drought tolerance is probably more important than shade tolerance for almácigo to gain dominance over competing vegetation. In transects of three plant associations in subtropical dry forests in Guanica, Puerto Rico, the almácigo basal area made up 2, 13, and 34 percent of the total for stems ≥5 cm (*21*). Three small stands dominated by almácigo in Cambalache and Guanica, Puerto Rico had average total basal areas of 18 $m^2$/ha, more than half of which was almácigo (author, personal observation). Although almácigo generally grows as a component of mixed stands, it is also found in pure or nearly pure stands (*20*).

**Damaging Agents.**—Although a number of damaging agents have been reported, none is known to be a serious threat to the species as a whole. Several homopterous insects have been reported feeding on almácigo foliage and twigs in Puerto Rico (*22*). The monkey, *Cebus capucinus,* in Costa Rica feeds on tender branch tips during refoliation at the end of the dry season and can strip entire trees (*35*).

Ambrosia beetles (*Xyleborus* spp. and *Platypus* spp.) attack green logs of almácigo, and powderpost beetles (*Lyctus* spp.) attack seasoned lumber (*20, 22*). *Lagochirus araneiformis* L. and other bark- and wood-boring insects also feed on logs and living trees (*22, 40*). Three termite species consume almácigo wood in Puerto Rico: *Incisitermes snyderi* Light, *Cryptotermes brevis* Walker, and *Nasutitermes costalis* Holmren (*22*). Although almácigo wood is listed as very susceptible to attack by the dry-wood termite, *C. brevis* (*42*), it can be rendered resistant to attack by being dipped in solutions of copper sulfate, zinc chloride, barium chloride, or cadmium nitrate (*41, 43*). Green almácigo wood has a high moisture content, and unless it is promptly sawed and dried or treated with fungicide, it will be attacked by sapstain fungi and will discolor to a shade of gray (*6, 20*). Almácigo wood is not durable in contact with the ground and, without preservative treatment, is not suitable for use in exposed situations (*20*). Untreated dry fenceposts had a service life of just 5 months in Puerto Rico but, with preservative treatment, remained serviceable for 4 to 7 years (*7*). Samples of wood from Venezuela incubated for 16 weeks at 27 °C and 75-percent relative humidity after inoculation with *Lenzites trabea* and *Polyporus versicolor* fungi lost 50 and 52 percent of their weights, respectively (*23*). Heartrot is also a common problem in large, old trees.

Almácigo is susceptible to fire injury owing to the combustible resin in its bark and wood (*11*). In frost-prone areas, almácigo trees planted as ornamentals will be damaged by a hard frost; however, mature trees can withstand occasional light winter frosts (*24*). Furthermore, Almácigo is wind resistant (*38*). Trees in Puerto Rico and the U.S. Virgin Islands, exposed to Hurricane Hugo in 1989 with maximum gusts of 150 to 330 km/hr, were stripped of leaves and twigs and suffered extensive breakage of minor branches. Although some major branches were broken, trunks of sound trees were not snapped, and few trees were windthrown (author, personal observation).

## SPECIAL USES

The foremost use of almácigo is for living fenceposts and hedges, which develop after green posts of the species take root (*3, 9, 17, 28*). In this capacity, the trees also provide shade along country roads (*11*). Almácigo is also an important ornamental and urban shade tree in dry and moist areas (*11, 24, 31*). Its medium size is convenient in residential areas, and its shiny green foliage and coppery, birchlike bark are very attractive (*17, 36*).

The wood of almácigo is a lustrous white to light brown, and the sapwood is not distinguishable from the heartwood (*20*). Specific gravities of 0.28 g/$cm^3$ (ovendry) from the Dominican Republic (*1*), 0.26 g/$cm^3$ (ovendry) from Mexico (*29*), 0.30 to 0.40 g/$cm^3$ (air-dry) from Belize (*20*), 0.32 g/$cm^3$ (ovendry) from Costa Rica (*38*), and 0.25 g/$cm^3$ (ovendry) from Puerto Rico (author, personal observation) indicate a lightweight wood. A moisture content in freshly cut wood of 88 percent (weight of water/weight of ovendry wood) is reported from Mexico (*29*).

The wood is soft and rated below pines, spruces, and firs in all strength properties except splitting, in which it compared favorably with these confiers (*20*). Almácigo wood, with 12-percent moisture content, demonstrated a bending strength of 138,000 newtons/$cm^2$, a modulus of elasticity of 21,000 newtons/$cm^2$, and a maximum crushing strength of 88,000 newtons/$cm^2$ (*6*). Shrinkage of the wood as it dries from green to ovendry is 2.3 percent radial, 3.6 percent tangential, and 8.6 percent volumetric (*20*). It air-dries at a moderate rate, generally without defects appearing (*37*). The wood saws, planes, and turns without difficulty. It stains and polishes well and holds nails firmly (*20*). Logs can be peeled on rotary lathes without preheating and yield a veneer comparable to paper birch (*Betula papyrifera* Marsh). (*20*). Predominant uses are for plywood, corestock, particleboard, matchsticks, boxes, and construction lumber (*2, 20, 27, 28*). With strength and pulping characteristics similar to *Gmelina arborea* Roxb. and commercial birch (*Betula* spp.) pulps, almácigo wood has a pulp yield of 50 percent and can be used to produce printing and writing paper (*26*). When thoroughly dry, the wood makes excellent kindling and is used extensively for firewood and charcoal (*24*). Almácigo wood is used for lumber and fuel primarily because of its abundance rather than because of its superior qualities.

[2] Personal communication, Ariel Lugo, Institute of Tropical Forestry, Río Piedras, Puerto Rico.

Almácigo trees produce a resin with a pitchy smell and feel that is used locally as a cheap glue, for incense, in folk medicine, and as a flavoring in confections and herb teas (*20, 25, 27*). The sugary sap is used in rural areas to feed babies and small children. The fleshy pericarp of the seed and the fleshy young shoots are consumed by numerous species of wildlife (*35*). People in some rural districts also cook the tender young shoots as a vegetable (*17*).

## GENETICS

There are about 90 species of trees and shrubs in the genus *Bursera* scattered across tropical America (*11, 28*). Botanical synonyms for *B. simaruba* are *B. gummifera* L., *B. ovalifolia* (Schlecht.) Engler, and *Elaphrium simaruba* (L.) Rose (*19*). Considerable variation in bark color and tree form across the range has led some botanists to believe there may be more than one species of almácigo present (*17*).

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